Exploiting the use of wikis to support collaborative writing: a case study of an undergraduate Computer Science class

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Abstract. Use of wikis in education reflects a shift in the education paradigm from lecture and individual homework-based to a paradigm emphasizing student engagement and the construction of knowledge through collaboration and peer-help. Existing research work on the use of wiki in collaborative writing had given mixed results. The goals of this research are to investigate whether wiki supports learning of writing and argumentation skills, and whether the students are motivated to use it and see it as a useful learning tool. Our participants comprise ten senior undergraduate students of a Computer Science class, who engaged in collaborative writing using wiki for four weeks. Their contributions were graded by a designated TA. The grades assigned to both their final articles and individual contributions, and the wiki logs were analyzed to determine the quality and volume of their weekly contributions, while feedback was taken from them using questionnaire to sample their perception of the use of wiki in writing. Our results showed that the use of wiki is helpful in improving their writing skill. However, participants are not happy with the further use of wiki in their course work. Also, we found that they require extrinsic motivation, in form of feedback (grades) from the TA and acceptance of their contribution by their peers, to increase their participation in wiki writing.

Keywords. Collaborative writing, motivation, collaborative learning, wiki

1 Introduction

Wikis are web pages that allow users to add, modify or delete contents, in collaboration with other users [26]. Wikipedia is the most famous application of wiki technology, ranking 5th, with 1.2 billion unique visitors, among all the websites [25]. Use of web 2.0 technologies like wikis in education reflects a shift in the education paradigm from lecture and individual homework-based to a paradigm emphasizing student engagement and the construction of knowledge through collaboration and peer-help, which according to the socio-constructivists are powerful sources of knowledge transfer [16]. Existing research works had focussed mainly on how wiki can enhance students' collaboration in collaborative learning and writing. Some of these studies had

mixed results [11], [13]. While some researchers found that wikis posses features that would be of great benefit to collaborative learning when an apt attention is given to sound pedagogy in its implementation [5], others found that wikis do not necessarily encourage collaboration among students [13]. Hence, the benefits of wiki in supporting collaborative learning still require further exploration with regards to whether it supports learning and collaboration. In this research, we used a modified wiki to support collaborative essay writing in a senior undergraduate Computer Science class, in order to discover whether it supports learning of writing and argumentation skills, and whether the students are motivated to use it and see it as a useful learning tool.

2 Related Work

In higher education, wikis are being used in collaborative learning and writing because of their ease of use and the availability of options for editing by different contributors with different levels of privileges [4, 5], [11], [13]. For example, [13] studied the use of wiki to support collaborative writing in an undergraduate class. In their study, participants were organized into four writing groups, each with a group leader, and they were engaged in a writing project which was broken down into four stages with deadlines. The researchers used the wiki logs to collect data about the volume of contributions of each participant, the degree of collaboration and interaction among group members, and the division of labor among them. Their findings showed that work was not evenly distributed among the group members and the group leaders made most of the wiki entries. Overall, they found a limited collaboration among the participants using the wiki, while they did bulk of their discussion and sharing of ideas via email. [21] also engaged 216 students in voluntary wiki writing over a period of two years, at the end of which their exam performance was used to judge the benefits of wiki writing. Their findings showed that students who were actively involved in the wiki writing performed better than the less active students in their final exams. One short coming of this study is that little or no emphasis was placed on participation in the wiki writing and there was no incentive to motivate participants to contribute [21]. [11] assessed students' collaborative learning behaviour using wiki. Their findings showed a high overall level of participation. However, they also found that the use of wiki does not necessarily enhance collaboration.

On the other hand, [4] discovered that wiki was a great tool to enhance collaboration among students, though with certain reported difficulties. However, their findings were based solely on self-reported data from the participants using questionnaires and not on log data or performance evaluation [4]. Self-reported data can give useful insights into the learner's acceptance of wiki technology and their perception of its usefulness to support learning. However, it is subjective and prone to bias [20].

We discovered that most of the research on wikis in education, particularly for collaborative writing in classrooms, rely on either self-reported data from participants (their perception of knowledge gained) or on wiki logs to determine whether wiki actually supports collaborative learning by various measures. Also, the few that combined both the wiki logs and students' feedback, however, did not investigate the qual-

ity of students' contribution and the helpfulness of using wiki on their writing skill over time [19], [22, 23].

Also, none of the existing works looked at factors that could motivate participation for wiki users in collaborative writing. Some researchers have proposed general strategies for motivating contributions to the online environments [3], [12], [18]. [3] described some principles that can aid collaborative learning, most importantly in online environments. Two of these principles are *positive interdependence*, which is to ensure that coursework and assessment are designed in a way to make the success of the individuals in the group depend on the success of the group; and *individual and group responsibilities*, which is used to give individual participant a sense of responsibility by grading their individual contributions [3].

[18] classified motivating factors into psychological and economic. Psychologically, some users are self-motivated to contribute, while few are obliged to keep contributing as a result of self-preservation considering the fact that they have invested their time and that their contributions are important to the online community [10], [14]. [12] stated anticipated reciprocity, increased recognition and sense of efficacy as the three motivations to contribute in online communities. [9] suggested three social rewarding mechanisms (implemented in MediaWiki) using: 1) quality and number of references, 2) rating of articles and 3) number of views on articles. The values along these three metrics can be combined in a two-step calculation process (*revision basis* and *author basis*) to find the active participants in the wikis. "*Revision basis*" refers to scoring every revision to an article based on the three social rewarding mechanisms, while "*author basis*" refers to assigning the sum of all scores accrued from every revision an author has made to the author [9]. Another approach proposes instantly rewarding editors with barnstars, points or warning signs that correlate with the quality of their contributions [7]. However, measuring the quality of contribution (participation) in wiki has always been an open research problem.

Many variables have been used to measure the quality of participation in wiki systems. A popular measure is the use of edit count, which is the number of characters or words that the editors contributed to the wiki. However, this metric gives the same credibility to both high quality and substandard contributions [24]. [6] suggested the use of edit sessions, which are the labor hours that each wiki editor puts into making contributions to the wiki articles. Although a slight correlation was found between edit session and edit count metrics, edit session as described by [6] might result in neglecting time spent behind the scenes doing other critical wiki activities. Also, the between session threshold of one hour might incorporate non-wiki activities, thereby overestimating the labor hours. Another measure is the use of editors' contributions that survive revisions by the other editors or administrators [1]. This refers to the number of characters, from the editors' contribution, which are not deleted from the wiki article or changed by the other editors. We see this approach as the most efficient, productive but inexpensive way to measure quality of participation since it considers only the useful contribution made by the editors.

Since the results from current studies have been inconclusive on the helpfulness of wiki in collaborative writing, due to their mixed results; in this study, we aim to clarify the effects of using wiki for collaborative writing in an undergraduate class and define the motivation strategies that can encourage both group and individual contributions in wiki collaborative writing. To do these, we will answer the following research questions -

Does collaborative writing using wiki help students to improve their writing skill?

What is the students' perception of the use of wikis for collaborative writing?

What strategies can be used to improve students' participation in collaborative writing using wiki?

To measure the editors' contribution, we used the metric by [1], which is the editors' contribution that survived revision by the other editors.

3 Research Tool

We developed a research tool, a wiki system, called *WikiMentor*, which is a customized MediaWiki system with a content authorship module. Therefore, a login is mandatory in *WikiMentor*. By comparing the content differences between every former and latter revision of an article, *WikiMentor* is able to figure out the authorship of each character and send email notification to the authors when their contents have been modified by others (see Figure 1).

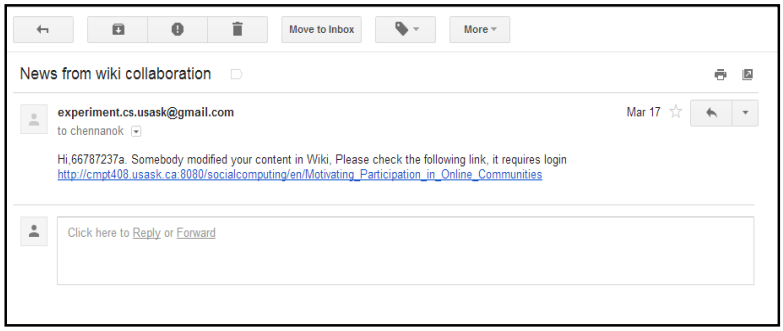

Fig. 1. Sample email notification

These emails only inform the editors that their contents have been changed, no further details are provided. Also, we modified the interface of the system by adding a dialog box (see Figure 2) in each wiki article page. The dialog box is triggered when the user revisits a page after she has edited some texts and there have been subsequent edits by others of her text. Two sub-functions are embedded in the dialog box, namely *content changes* and acceptance/*evaluation of changes*. '*Content changes*' lists all modifications of an article made between the newest version and the latest version contributed by the user in reverse chronological order. It further helps users to locate the modifications by highlighting the added (or deleted) content in the original place of the text.

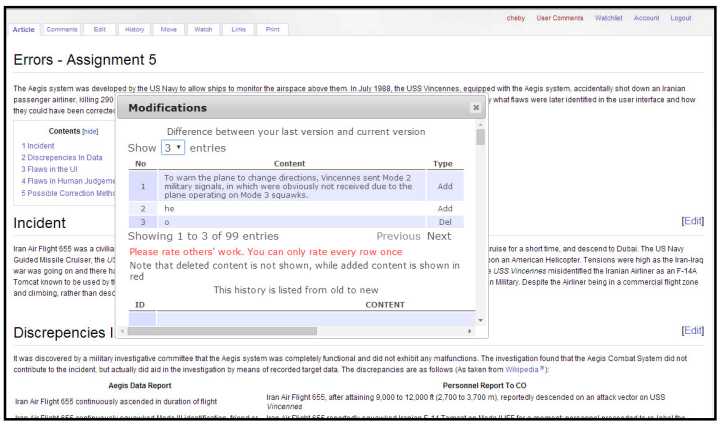

Fig. 2. Dialogue box showing content changes & acceptance/evaluation of changes

In this way, the users become aware of every change made to the article after the last time they logged into the system and made edits. For each change of content contributed by the user, there is the function ‘‘Accept change‘‘, which allows the user to accept or reject the change. The acceptance is considered equivalent to a positive rating (+1), referred to as r in the formula below, and rejection – to negative rating (-1), referred to as s in the formula below. We compute the user’s reputation from the acceptance or rejection, collected from the different users whose contributions were edited by the user using the formula below [15].

$$T = (r+1)/(r+s+2)$$

Where T refers to reputation, r refers to the number of accepted changes, while s refers to the number of rejected changes. For example, an editor would have a reputation of 0.67 at a point when r=+1 and s=0. In addition to the generic features of a wiki system, we included the following features to the WikiMentor:

Email notification when changes are made to editor's contribution;

Highlighting changes made to every editor's contribution;

Opportunity to accept or deny changes made to their contribution;

Computation of each editor’s reputation based on the acceptance or denial of their contribution or changes.

While the reputation value was not visible to the editors, it was used in the analysis to check the editors' responses with the system data.

4 Research Method

We recruited 10 undergraduate students of a senior undergraduate computer science class on ethics, who engaged in four collaborative writing sessions required for

their coursework using WikiMentor. Therefore, the wiki editors in our case were the students. The coursework required the students to write collaboratively essays on different topics assigned by the instructor each week. The students created the wiki page dedicated for the weekly assignment. There was no designated author responsible for each wiki page. The students were encouraged to contribute to the wiki assigned each week using pseudonyms. Students could add new contents, edit and delete the existing contents of the wiki. In order to ensure that students make distinct and meaningful contribution, their contributions to each wiki article were graded by a designated teaching assistant (TA), who is a senior graduate student and has taught the class as Sessional instructor. We only had one marker in order to prevent increase in the cost of the experiment since the TAs (markers) would be paid and also to avoid complexity that might arise from giving conflicting feedback to the students from different markers. The grading was done by assigning one grade for the final article and then deviations of this mark (both positive and negative within 15%) were assigned to individual students based on how substantial was their individual contribution, judged by the TA. In this way we aimed to create positive interdependence among the students and as well enforce both group and individual responsibilities, since they all know that not only does the entire group contribution matter, but their individual contributions also count towards their final grades. In order to mitigate the subjectivity of the marks given by the TA, the grading of their final article was based on three criteria with some weights assigned to each criteria, 1) issues raised, weight 0.3; 2) completeness and logic of the argumentation, weight 0.4; and 3) writing style and grammar, weight 0.3. Students had seven days to make contributions to each wiki article, after which the article was locked and grading started.

For every edit made to their contribution, each student got notified by email and the resulting changes were highlighted within the individual interface of the wiki system. Therefore, the user could either accept or reject the changes and this translated into a rating value of the change, that could be either positive (+1/accept) or negative (-1/deny), and was used in computing the reputation of the student who did the change as described in the previous section. We did not reveal the calculated reputation values to prevent the students from cheating or gaming the system. However, they were aware that their edits to others' contributions would either be accepted or rejected.

For each participant, we collected data on the number of characters contributed and the number of characters of their contributions that survived revisions by the other participants, the revisions that they made, the time they spent making their contributions and revisions, the numbers of their revisions that were accepted or rejected by the authors. Also, we kept history of their contributions and revisions, which could be viewed from the “history” tab once they logged in to the wiki system. At the end of the term, participants were given an exit questionnaire to evaluate their experience.

5 Results and Discussion

1 Does collaborative writing using wiki help students to improve their writing skill?

The participants engaged in collaborative writing using wiki for 4 weeks. There was no designated group leader or author. Therefore, anybody could start each wiki article while others joined in adding more texts. At the end of each weekly article, we sent them the grades assigned to both their final article and their individual contributions, by the TA. These grades were used to ensure group and individual responsibilities [3]. Grades assigned to the final articles over the four weeks are shown in figure 3. We found that there was a positive improvement in their grades from 75% in the first week to 90% in the fourth week.

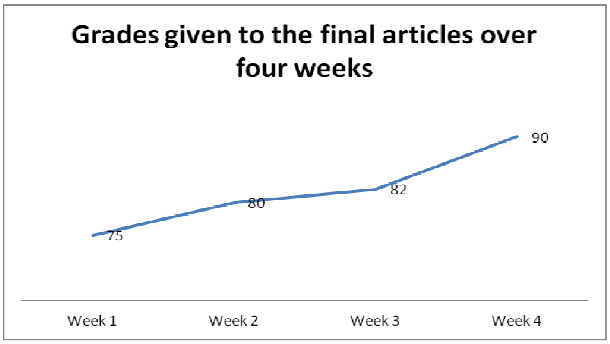

Fig. 3. Grades given to the final articles for the four weeks

We also found a growing trend in their average individual grades over the four weeks from 78.60% in the first week to 91.89% in the fourth week (Table 1).

Table 1. Grades assigned to individual contributions

Users	Wiki1	Wiki2	Wiki3	Wiki4
A	75.00	90.00	87.00	95.00
B	80.00	80.00	82.00	95.00
C	77.00	80.00	82.00	85.00
D	85.00	85.00	94.00	93.00
E	75.00	75.00	77.00	87.00
F	77.00	80.00	90.00	90.00
G	75.00	90.00	100.00	100.00
H	85.00	90.00	77.00	97.00

I	77.00	-	75.00	-
J	80.00	75.00	77.00	85.00
Average	**78.60**	**82.78**	**84.10**	**91.89**

We collected data on the number of their contributed characters that survived revision by the other participants. The individual weekly contribution quality (WCQ) for each student was calculated using the formula (results in Table 2)

WCQ_i = (#characters owned by i in the final version) / (#characters contributed by i over the week in total).

The results show a growing trend in the quality of the weekly contributions of some of the participants, except in week 1 when they mostly had very high weekly contribution quality. One reason that can be attributed to these high values is that majority of the students gave their contributions towards the deadline, when it was practically impossible for the other students to edit their contributions. The result also shows a decline from a high class average in week 1 to a lower class average in week 2. This can be attributed to the last minute contributions made by the students, which had a huge impact on the overall class average. There was a growing trend in the subsequent weeks, except in the week 4, when the values dipped lower (and there was an outlier of 0.332), still a good trend on the overall.

Table 2. Weekly contribution quality for each student

User	**Week 1**	**Week 2**	**Week 3**	**Week 4**
A	0.9895	0.9058	0.9975	1
B	No contribution	0.5527	0.6967	0.9422
C	1	0.993	0.908	1
D	0.8201	0.9981	0.9336	0.9993
E	1	0.7008	0.9545	0.9282
F	1	1	0.9778	0.911
G	0.9523	0.7222	0.9973	0.9501
H	0.9994	0.9911	1	1
I	1	No contribution	0.9846	No contribution
J	0.9991	0.7897	0.9925	0.332
Average	**0.9734**	**0.8504**	**0.9443**	**0.8959**

2 What is the students' perception of the use of wikis for collaborative writing?

Participants were given exit questionnaire. The exit questionnaire contained questions aimed at sampling their opinions about the competence of other contributors, the helpfulness of the wiki system in improving their writing, their satisfaction with the wiki system and the motivational strategies, which we included in the wiki system, that helped their writing and learning. We received 10 responses, though few of them abstained from answering certain questions.

We asked questions about their general impression of the other contributors to the wiki articles. The options given and the summary of their responses are presented in table 3.

Table 3. Participants' perception of other contributors

Options	**Number of respondents (out of 10)**
Competent	6
Provided detailed contribution	6
Helpful	6
Not helpful	1
Not competent	1
Lacked substance	1

Participants found other contributors to be competent, detailed and helpful on the average, which is also confirmed in their comments. e.g.

"*I found sometimes people were too thorough, and by the time I went to record my thoughts, everything I wanted to say had already been said*."

We asked to know if they were actually comfortable with using wiki system and 80% said they were very comfortable. Although they used pseudonyms while contributing to the wiki articles and they expressed that they were comfortable with using wiki, we discovered from their comments that few of them have reservation for editing other contributors' contents, while some did not have problem with this. Some of their comments are quoted below:

"*It was uncomfortable deleting other people's work, but I was comfortable expressing my own ideas*"

"*... I have no reservations about editing*."

Also, 60% of the participants objected to the further use of wiki in their coursework. Some of the reasons that they gave are quoted below.

" ...the *wiki was a forced exercise in frustration, boredom, and annoyance*"

" *With the wiki, what I wanted to say was often already said by someone else*"

This shows that, although there was a noticeable improvement in their writing, participants did not like to use Wiki in their collaborative writing, because they see it as a forceful and boring exercise.

We found out that participants found other contributors to be competent, helpful and detailed in their contributions. Although, 80% of participants feel they were comfortable with using the wiki system, we found out that some of them still hold some reservation for editing other contributors' contents. Many factors could have contributed to this that we hope to found out in our future work. Despite their positive attitude towards other contributors and their expressed competence in the use of wiki, participants were generally not happy with the further use of wiki in their collaborative writing.

3 What strategies can be used to improve students' participation in collaborative writing using wiki?

We asked participants about the features of the wiki system that motivated them to keep participating in the collaborative writing process. Participants could select as many features as were applicable to them on the list. See table 4 for the summary of the options and the selection made by the participants.

Table 4. Participants' preference for motivation strategies

Options	**Number of respondents (out of 10)**
The open contribution format of collaboration	6
Free writing style in wiki	6
The email notification when changes were made to their contents,	3
The highlighting of the changes made to their contents,	4
Their perceived status to their peers	7
Use of pseudonyms	2
Marks given by the TA	6

As shown in table 4, only four of the options were chosen by more than five participants at a time. These are "The open contribution format of collaboration" (6) , "Free writing style in wiki" (6), "The perceived status to their peers" (7) and "Marks given by the TA" (6).

These results showed that wiki editors actually required motivation, even if used for educational purpose. Their perceived status was borne out of their reputation score, which was not visible to the participants, but computed from the acceptance or rejection of their contribution to the wiki articles. This showed that participants care about the acceptance and rejection of their contributions by other participants, and the awareness of such feature could motivate them to ensure that they always make reasonable contribution. Also, participants got to see both their group and individual marks from every weekly article, before they moved on to the next wiki article. The results here showed that they are motivated by the feedback from the marks and the

marker's comments that they received weekly from their contributions. Overall, students are generally motivated by approval or feedback from their peers and an authority figure, in this case, the teaching assistant (TA). Two selected options, free writing style and open contribution, are characteristic of any wiki system, which corroborates the findings by [5] that the ease of use of wiki makes it a valuable tool in collaborative learning. The other two popular options (perceived status to their peers and marks given by the TA) correspond to enhanced performance feedback that can be usefully and easily incorporated in educational wiki systems. It was disappointing to find that the other new features introduced in our wiki, aiming to increase awareness of peer-feedback (the email notification when changes were made to their contents, the highlighting of the changes made to their contents, emphasizing fact that other editors are accepting or rejecting their contents, and the use of pseudonyms to encourage students to be more critical) were not chosen as motivating students to participate in the system. Yet the students could only be aware of their reputation by being aware of the accepted changes that they made to their classmates' contributions. So it is possible that in answering this question, they focused on the higher motives for participation, assuming that the others (not selected items) are just technical means to achieve them. Further research will seek to clarify this issue.

4 Conclusion

A lot of research that had been conducted on wiki and collaborative learning were mostly targeted at whether wiki actually encourages collaboration or not. However, in this research, we studied the effects of the use of wiki as a source of peer feedback on improving writing skill and helping participants in collaborative learning. We also looked at the motivation strategies that can trigger meaningful contributions to wiki. The participants felt that wiki was not really helpful and it was rather a boring activity; however, the quality of their writing improved, both measured by the proportion of contributed text that remained in the final article and the grades assigned by the marker (TA) based on the quality of the collaboratively written article and the individual contributions to it. The findings from this study show that the wiki writing exercises are helpful in improving students writing skill and that self-report from users is not enough when measuring cognitive and affective states. Our results also suggest that students require extrinsic motivation in form of feedback from their peers and an authority figure (e.g. instructor, TA) to enhance their quality of contribution to wiki.

There are few limitations to this study. This study was designed with ten participants, which is a small sample size. Hence, the results from the study cannot be generalized. However, it serves as a basis for future studies with large sample size. Also the participants only worked as one group, comprising of ten participants working together on a wiki article at the same. However, research had shown that for wiki to be effective as a collaborative writing tool group interaction and discussion are necessary conditions [8]. Research had also shown that small groups enhance group interaction and cohesion [17]. Therefore in our future work, we will deploy the wiki tool in a larger class, where students will be grouped into small group sizes (3 to 4 in each

group) for collaborative writing. In addition, we only had one marker. To improve the reliability of the grades assigned, we could use two expert markers and calculate the discrepancy in their scores. However, this will significantly increase the costs in an already costly experiment in a real class environment and may produce conflicting feedback to the students.

Despite the limitations, this study is pivotal for teachers, who will like to deploy wiki for collaborative writing in their classrooms. The findings here show that students require extrinsic motivation to participate in wiki writing. Therefore, teachers should consider the use of appropriate motivational features while deploying wikis, and that they should not only rely on the feedback from the students, but also feedback from an authoritative person (TA or marker), to measure the impacts of the use of wiki in collaborative writing.

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